NATIONAL RENEWABLE ENERGY LABORATORY

STRATEGIC PLAN

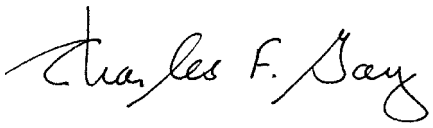
November 1996

FROM THE DIRECTOR

The National Renewable Energy Laboratory (NREL) is a key contributor to the U.S. Department of Energy (DOE) effort to secure a sustainable energy supply for the Nation. NREL serves as the DOE's lead laboratory in developing renewable energy technologies and is a primary laboratory for developing energy efficiency technologies.

The NREL Strategic Plan describes the basic principles that the Lab uses to guide its work. The Plan defines the Lab's strategic framework for setting goals, allocating resources and managing its operations, and identifies performance measures for objectively evaluating the Lab's progress. The Plan is intended to serve as a foundation upon which Lab personnel build their specific research, development and deployment programs, and through which others can come to better understand NREL's work.

With NREL's leadership, renewable and energy efficiency technologies have made tremendous strides forward in improved performance, reliability and cost competitiveness. With NREL's assistance and collaboration, the U.S. renewables and energy efficiency industries have grown rapidly and have secured leadership positions in international energy markets. The NREL Strategic Plan outlines the Lab's strategic framework for continuing this success.



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NATIONAL RENEWABLE ENERGY LABORATORY STRATEGIC PLAN

Purposes of this Plan

The purposes of the National Renewable Energy Laboratory (NREL) Strategic Plan are to:

- Define a strategic framework for center-level planning and decisions.
- Communicate to stakeholders the strategies that will guide NREL in support of its mission and in support of the U.S. Department of Energy, with particular emphasis on a 3–5-year horizon.
- Provide a strategic basis for budgeting, personnel, facility, and other key Laboratory decisions.
- Identify the performance measures that will be used to gauge progress toward each strategy.

I. INTRODUCTION

Stable, clean energy supplies are essential to the security and prosperity of the nation. At present, American utilities rely on low-cost fossil fuels to provide most of the energy for industry and buildings. With petroleum imports now surpassing the 50% mark, the nation is at ever-greater risk for disruption of vital fuel supplies for transportation. At the same time, as the environmental impacts of fossil-fuel extraction, conversion, and use become of greater concern, the nation is faced with the fundamental challenge of how to ensure a sustainable energy future.

The federal government addressed this challenge in *Sustainable Energy Strategy*, in which it defined the country's energy policy plan by setting the following national goals:

- Maximize energy productivity to strengthen our economy and improve living standards.
- Minimize pollution to reduce the adverse environmental impacts associated with energy production, delivery, and use.
- Keep America secure by reducing our vulnerability to energy supply disruption and cost fluctuation.[1]

Renewable energy and energy efficiency technologies are core components of a diverse energy-source portfolio, as recognized in the report of the Secretary of Energy's Task Force on Strategic Energy Research and Development.[2] Notwithstanding current debates over near-term federal energy research and development (R&D) funding, there is emerging agreement that these technologies will be of critical importance to future energy supplies. Shell International, one of the world's major petroleum corporations, recently summarized its views on energy demands and markets as follows:

> It soon becomes obvious to anyone who looks seriously at the question of how energy demand growth can be satisfied in the longer term that ... before too long renewable sources of energy will have to start to play an increasingly important

> role. We should, therefore, regard the stimulation of the development of new energy sources as complementary to the continued development of oil, gas and coal and not as a threat. There will be need and room for all in the energy markets of most of the 21st Century.[3]

While the world confronts questions not only of energy use but of global climate change and prudent control of fissile nuclear materials, developing countries are increasing their energy consumption. Urban air pollution and resulting health problems are plaguing more and more cities in the developing world. As energy markets increasingly transcend national borders and regional influences, renewable energy and energy efficiency technologies are playing an increasingly important role. Developing and marketing advanced energy technologies provide increasing leverage in ensuring national economic growth and industrial prosperity. America cannot afford to lose its position as the technological leader in sustainable energy technologies.

DOE, NREL, and MRI

The U.S. Department of Energy (DOE) directs the federal government's investment in energy research and development. The task of the DOE Office of Energy Efficiency and Renewable Energy (EE) is to manage DOE's investment in renewable energy and energy efficiency technologies. NREL is the nation's lead laboratory for developing renewable energy technologies, and is a primary laboratory for developing energy efficiency technologies.[4] EE is NREL's primary source of funds, and, in turn, NREL is EE's primary conduit for accomplishing its mission. NREL is owned by the federal government, and is managed and operated for DOE by the Midwest Research Institute (MRI).

DOE 's vision for the energy future of the United States is as follows: "In our vision for the year 2010 and beyond, the United States will be a worldwide leader in the development, application, and export of sustainable, environmentally attractive and economically competitive energy systems...."[5]

NREL's vision is directed at helping DOE achieve its vision: "NREL will be central to the transition to a sustainable energy future. We will be the preeminent institution for renewable energy and energy efficiency R&D and deployment. Our hallmarks will be a spirit of innovation, collaboration, and teamwork committed to improve continuously all that we do." [6]

NREL's Mission

Lead the nation toward a sustainable energy future by developing renewable energy technologies, improving energy efficiency, advancing related science and engineering, and facilitating commercialization

NREL's mission[7] (see box) directly complements the following mission of EE: "Lead the nation to a stronger economy, a cleaner environment, and a more secure future through the development and deployment of sustainable energy technologies."

MRI is committed to providing NREL with the effective management, the scientific and technical staff, and the cost-effective operations that NREL needs to accomplish its mission.

The National Renewable Energy Laboratory

The basic principles upon which NREL bases its operations and activities are as follows:

- Everything we do is driven by our mission.
- We will use our resources effectively to achieve world-class laboratory operations.
- We work in partnership with other laboratories, U.S. industry, academia, and energy end-users.
- Our primary focus is to advance R&D for—and facilitate the deployment of—renewable energy and energy efficiency technologies.
- We will serve as the world's leading and most comprehensive center of renewable energy and energy efficiency science and technology, acknowledging the important strengths and contributions of our partners.
- We push the leading edge in integrating science and technology.
- We assist with energy solutions that support sustainable development and mitigate environmental problems.
- We are committed to providing the best possible working environment to help our staff achieve excellence, including strong programs in environment, safety, and health.

NREL's primary business and service is R&D; technology management services support this primary business. NREL's ultimate customers are the future generations of U.S. citizens. We will serve those future generations best by serving our immediate customers well. NREL's immediate customers include DOE, U.S. renewable energy and energy efficiency companies, and energy end users such as utilities, U.S. industry, and the American public. As NREL's principal source of funding, DOE represents a very important customer or investor for the Laboratory. The adjacent box lists NREL's major customers and the DOE programs that NREL supports.

NREL's Major Customers and DOE Programs

- Energy generators and consumers (including utilities, independent power producers, U.S. industry, and the American public)
- U.S. renewable energy and energy efficiency companies
- DOE/EE Office of Utility Technologies
  - Photovoltaics
  - Wind
  - Hydrogen
  - Solar Thermal
  - Biomass Power
  - Resource Assessment
  - Analytic Studies
  - Geothermal
  - Superconductivity
- DOE/EE Office of Transportation Technologies
  - Hybrid Vehicles
  - Biofuels
  - Alternative Fuels Utilization
- DOE/EE Office of Building Technology, State and Community Programs
- DOE/EE Office of Industrial Technologies
- DOE/EE Office of Federal Energy Management Programs
- DOE/EE Office of Budget, Planning and Customer Services
  - Analytic Studies
  - Technical Information
  - Information Services
- DOE Office of Energy Research

NREL's strengths in science, technology, and administration result directly from the Laboratory's world-class scientific, engineering, and administrative staff, totalling more than 700 regular employees and dozens of visiting researchers from around the world who work at NREL each year. NREL's facilities are also strong assets that support the Laboratory's unique mission, with several new state-of-the-art technical facilities that have been constructed recently with EE capital funds.

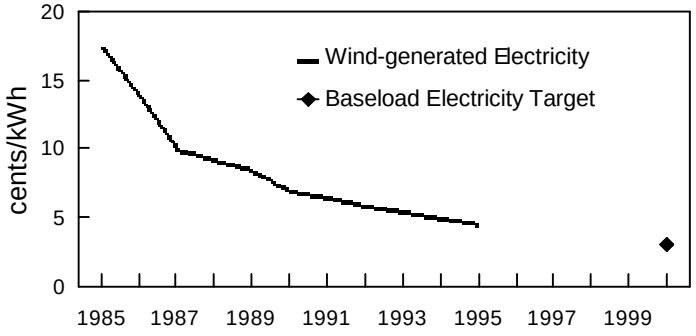
NREL—Building on Success

Throughout its existence, NREL has focussed on its single mission to develop renewable energy and energy efficiency technologies. Advances in the scientific understanding of these energy areas, and application of our technology developments together with our industry partners, represent the unchanging foundation of our work.

Examples of these advances include repeated new records for conversion efficiency of photovoltaic materials, combined with greater fundamental understanding of these materials; advances in blade design and performance for wind turbines; significant progress in genetic engineering of enzymatic-like materials for bioconversion of biomass and waste to alternative fuels; new methods for converting waste products to useful chemicals; advances in the science of whole buildings and indoor air quality; cutting-edge research on various photoconversion and energy storage processes; and improved understanding of the renewable resources of the United States and the world.

One measure of success is in the ability of an organization to set and meet technical goals. Figure 1 shows the success of NREL, the U.S. wind industry, Sandia National Laboratories, Pacific Northwest National Laboratory, and other contributors in steadily lowering the cost of wind-generated electricity, heading toward the current target for the baseline cost of electricity.

Figure 1: Reduced Cost of Wind-Generated Electricity



Source: World Bank (1994) cost data

Great strides have been made in performance, reliability, and cost reductions for all renewable and energy efficiency technologies. However, continued innovation of new technologies is essential to their ultimate success and stability in the competitive marketplace.

II. NREL'S STRATEGIES

NREL defines its strategies for achieving its mission around the strategic components of the nation's sustainable energy policy plan, which are to:

- Increase the efficiency of energy use.
- Develop a balanced domestic energy resource portfolio.
- Invest in science and technology.
- Re-invent environmental protection.
- Engage the international market.[8]

NREL's leadership team met several times to discuss the issues facing the Laboratory today, and the strategic directions provided by DOE and others. Several of NREL's senior managers also met with EE senior managers. As a result of these discussions, NREL has determined that its major strategies for contributing to these national energy policy plan strategic components are to:

- Expand NREL's capabilities for research, development, and deployment assistance for DOE
- Support science and technology with world-class operations
- Strengthen integration of our work with others through partnerships
- Increase leveraging of EE funding

These major strategies form the core of NREL's Strategic Plan and guide how NREL is directing its activities and managing its operations. In addition, these strategies are designed to achieve the Laboratory's mission and contribute to the nation's sustainable energy strategy.

Strategy 1: Expand NREL's capabilities for research, development, and deployment assistance for DOE

NREL serves as the focal point for most of DOE's renewable energy programs, and several energy efficiency programs. NREL must work with EE to ensure that these programs have the depth and breadth necessary to achieve the aims of DOE. NREL's mission extends from basic science research to system development to facilitation of private sector commercialization (deployment); NREL's continued success in delivering on its mission requires that the Laboratory appropriately emphasize the full balance among its activities.

NREL has a sustained history of success in basic and applied research and development, as judged by frequent scientific peer reviews of NREL programs and the Laboratory's ultimate success in affecting the technologies that become commercialized. By working with its university partners, researchers at other national and international facilities, and DOE's Office of Energy Research, NREL will strive to ensure that basic and applied research "keeps the technology pipelines filled" with new concepts, new materials, new processes, and new devices to be developed with NREL's partners. The Laboratory will contribute to meeting the nation's need for basic research that is increasingly short-changed by today's highly competitive business environment.

Research and development bears the most fruit when it results in the development of technology that is adopted by the private sector. While U.S. companies bear the burden of

commercialization, NREL contributes technical knowledge to help overcome system design and manufacturing problems; provides analyses of market and economic issues; and brings together the technical, financial, and business interests for the synergy necessary to ensure the success of renewable energy and energy efficiency projects. Building on past successes in the Federal Energy Management Program, international development of renewable energy projects, and other areas, NREL will continue building its capabilities to serve EE across the full breadth of NREL's mission.

To meet the need for integrated, full-spectrum R&D programs in key renewable energy and energy efficiency technologies, NREL recognizes the strategic need for a central focus, or "center of excellence," for the technical work of these key programs. A center of excellence provides all elements necessary to put a technology in place, such as a critical mass of technical staff with extensive depth and breadth of knowledge about the technology, scientific and engineering leadership and focus for all the technical contributors to a program (including other laboratories, industry, and universities), a central point for disseminating technical information, and specialized facilities for research and development.

This concept is not new; NREL pioneered the concept of technical centers of excellence with the National Wind Technology Center. NREL also worked with Sandia to spearhead the formation of SunLab, a "virtual" laboratory for solar thermal electric technology development. Building on that success, NREL intends to formulate additional technical centers of excellence in the coming years, as described in detail below.

Along with the centers of excellence, NREL will continue its current R&D programs, including its international leadership in wind energy technology development, and its activities to support hybrid vehicle development, industrial technology development, environmental technologies, and solar thermal technologies. NREL is considering centers of excellence in other technical areas; the initial strategic emphasis will be on photovoltaics, while centers in biomass conversion and hydrogen are under consideration. In other technical areas—alternative fuels, building energy technologies, analysis, fundamental research, and information—NREL is evaluating selected new initiatives to better marshal the resources within DOE and elsewhere to accomplish specific tasks. Several of these new ideas for centers and initiatives are discussed below.

National Center for Photovoltaics

NREL will serve as the central location for the National Center for Photovoltaics, being created by DOE to serve as the focal point for technology development and information dissemination about photovoltaics in the United States. The Center will build on and link the core set of facilities and expert staff at NREL and Sandia National Laboratories, with additional resources in universities, industry, and other federal and state programs, into a united effort to accelerate the advance of photovoltaic technologies as an industry and energy source.

The Center will enhance communication for those involved in photovoltaics and support outreach to those who seek technical information. It should catalyze strategic partnerships and alliances among photovoltaic stakeholders and will support drawing in new interests from industries whose financial resources, technology, or applications can augment the direct efforts of the photovoltaics industry.

One of the attractive opportunities for the Center is the scale-up and transfer of very promising

thin-film technology. NREL has reached major milestones in the development of thin-film technology; however, much more research is needed to better understand the material science and properties of these films, their process parameters, and device scale-up engineering. The Center has the right expertise to solidify the scientific foundation upon which U.S. industry could commercialize this technology.

The Center should also be instrumental in resolving the next major problem in the worldwide development of photovoltaic technology, that of very large-scale manufacturing. The Center has the resources to conduct the R&D for such major technical advances as on-site production of chemicals for deposition, in situ measurements and characterizations, recovery of raw materials during processing, and intelligent manufacturing using detailed reaction analysis.

National Biomass Conversion Center

NREL performs world-class research on the efficient and cost-effective conversion of biomass resources to useful products and energy. The various federal sponsors of advanced biomass conversion research are being integrated into the Bioenergy Initiative involving DOE, the U.S. Department of Agriculture, the U.S. Environmental Protection Agency, and the White House Office of Science and Technology Policy. In support of this initiative, NREL intends to be a leader in the global development of biomass as an effective renewable resource.

The primary goal is to leverage NREL's current activities and facilities with those of industry to speed the development and commercialization of successful concepts. NREL will establish the National Biomass Conversion Center to fully utilize its world-class research capabilities to fill the need for coordination and cooperation of biomass development and applications among DOE and other agency laboratories. NREL's acclaimed scientific expertise in biomass conversion will remain the heart of the new Center, while strategic partnerships and alliances will be central to the operation of the Center. These allies will include state and local organizations seeking to utilize biomass resources, as well as other key stakeholders.

Center of Excellence for Renewable Hydrogen Energy Systems

NREL has established itself as a leading national laboratory for hydrogen research and development, including expertise in producing hydrogen from renewable energy sources, advanced materials for storage, hydrogen detection, and process and system analysis. NREL's current hydrogen research activities include the private sector commercialization of an NREL-developed fiber-optic hydrogen sensor and an industry-led production project using NREL's High-Flux Solar Furnace facility. NREL has proposed to form a Center of Excellence for Renewable Hydrogen Energy Systems to serve as the focal point for basic and applied research in hydrogen. Potential industry collaborations include technology based on amorphous silicon for photoelectrochemical hydrogen production and advanced reformer technology for renewable biomass-powered fuel cells.

Integrated Technologies for Buildings

Technology advances make it possible to reduce the energy consumption of a typical building by 30%–90% at relatively low construction cost; however, the design expertise needed to implement these advances is beyond the reach of most commercial architectural and engineering firms. NREL has unique expertise in the design and operations requirements necessary to maximize

the efficiency of energy use in buildings, and to apply renewable energy technologies to buildings.

Working with other DOE labs, NREL intends to develop better design tools for integrating and optimizing the application of renewable energy and energy efficiency technologies in buildings, including photovoltaics and electrochromics. The computerized design tools envisioned would allow architects and builders to more readily incorporate these technologies into buildings and communities, including those in less developed countries. The new tools would also address sustainability issues, such as recyclability of building materials, and passive features appropriate for the international community. Developing these design tools will require advances in a number of building science-related R&D activities, including the development of new technology in collaboration with industry and laboratory and field testing. New design tools would be augmented by NREL's Thermal Test Facility and complementary facilities elsewhere, e.g., the roof-testing facility at Oak Ridge National Laboratory and the window-testing facility at Lawrence Berkeley National Laboratory. To encourage industry collaboration, NREL's Thermal Test Facility would be designated as a National User Facility.

Alternative Fuels Utilization

NREL has been involved for some time in administering subcontracted research in alternative fuels utilization, including engine optimization and atmospheric reactions. NREL has the expertise to make unique contributions in computer modeling of components and systems to evaluate alternative fuel vehicle technology. Computer modeling would allow the evaluation of the commercial potential of different automotive technologies without having to build expensive engine and vehicle test cells or fund multiple hardware-testing subcontracts. NREL could make valuable contributions in providing reliable, independent fuel and component test data, and could perform atmospheric computer modeling to determine the effects of alternative fuel vehicles on air quality.

Expansion of Fundamental Research

NREL has recently begun work in several new areas that are jointly supported by EE and ER. This integration has strengthened EE's technology development through basic understanding of materials and chemical processes provided by ER. NREL intends to continue its strong programs in fundamental research to support photovoltaics and expand into several new areas. For example, NREL strengths in photoconversion, and chemical and biological sciences, will be applied to environmental management research; strengths in catalysis, photoelectrochemistry, solid-state physics, materials science, and other areas will support a broader spectrum of energy conversion technologies, such as advanced vehicle research and advanced building component research.

Energy Market Analyses

NREL's commitment to national leadership in the research and development of renewable energy technologies implies the planning and conduct of programs that have a strong focus on the value and relevance of renewable energy systems in the energy marketplace. This initiative is directed toward improving the Laboratory's focus on this national goal by developing a clear understanding of the energy economy and its implications for renewable energy technologies. Specifically, this initiative will acquire and analyze information on: the performance, cost, and

operational characteristics that will be necessary for renewable energy technologies to succeed in the energy marketplace; the environmental and climatic benefits of expanding use of renewable energy technologies; the financing mechanisms that will be the most relevant for deploying renewable energy systems and the implications of those mechanisms for renewable energy technologies; the information about renewable energy technologies that energy markets and market decisionmakers will need and the most effective mechanisms for disseminating that information; and finally, the most effective ways to provide support to those energy market decisionmakers and public stakeholders who have a strong interest in the adoption and use of renewable energy systems.

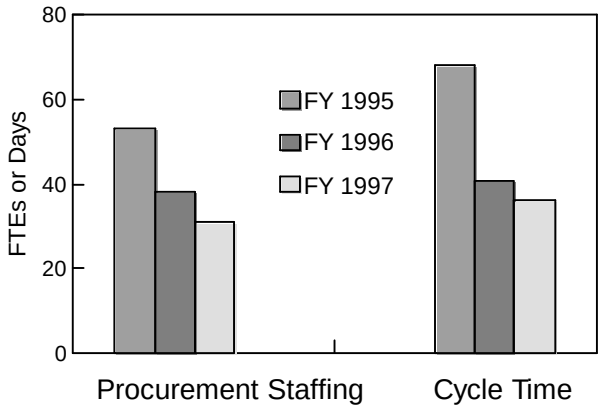
Information Communication

NREL already serves as a central communications point for information about renewable energy and energy efficiency technologies, through its management of public information services the Energy Efficiency and Renewable Energy Clearinghouse and Network for EE, a robust and innovative Internet presence, extensive databases available to the public, a world-class library, and hundreds of publications produced each year. A key strategic element of expanding NREL's capabilities, and supporting new centers of excellence, is to expand and improve the quality and accessibility of information about these technologies.

Strategy 2: Support science and technology with world-class operations

Maximizing the return on the nation's investment in NREL requires that the Laboratory achieve exceptional quality and cost-effectiveness in its operations. NREL is committed to an ongoing program of innovation and restructuring to improve its operations.

Figure 2: Lower Costs and Faster Processing in NREL Subcontracting



In 1995 and 1996, NREL's self-initiated NREL 2000 reengineering project dramatically increased the Lab's operational efficiency. Some specific NREL 2000 accomplishments are shown in Figure 2 and the following table.

One of the key results of the NREL 2000 reengineering project was a new organizational structure for the Laboratory. A total of 24 centers and offices report to the deputy director. The new structure supports the DOE and NREL mission through organizing NREL's research and development capabilities into 12 centers of technical excellence. There are also 10 administrative centers and offices, and 2 centers to support the development of partnerships and new business ventures for the Laboratory.

This organizational structure was chosen to encourage cross-fertilization of ideas, fewer layers of management, team-based management at all levels, and more accountability at all levels of the organization. As one example of the practical working of this structure, some technical programs require resources from multiple centers. The technology manager who leads each program works with the required center directors to identify and commit the resources needed to

carry out the work of the program.

NREL 2000 Accomplishments

- Implemented a center-of-excellence organizational structure
- Improved leadership through councils and teams
- Eliminated one to three layers of management
- Selected senior leaders (many new) to ensure the best possible leadership team
- Positioned Lab to have critical skills needed to fulfill mission with reduced budget; strategically reduced total number of employees by more than 200 (23%) to meet new budget levels
- Reduced managers by 54, saving $1.5 million annually in salary and fringe benefits
- Increased diversity among supervisory and management ranks to 35%
- Implemented new system for competitive R&D subcontracting, reducing cycletime by 48% and cost (hourly rate) by 20%
- Implemented credit card system for small purchases, reducing the transaction workload by 85% and the number of employees in the purchasing unit by 32%
- Redesigned information technology work processes and structure
- Streamlined reporting requirements
- Established a shared equipment database
- Developed a new program for fostering creativity within the Laboratory-directed R&D program
- Designed project management improvements
- Improved and streamlined the process for complementing our base funding with diverse sources that support our mission.

As another example of team-based management, three councils have important responsibilities in Laboratory management and leadership. Directors of technical centers constitute the R&D Council, which meets regularly to provide technical direction for the Laboratory. Directors of administrative centers constitute the Business Council, which meets regularly to provide direction for the Laboratory in administrative support areas. These two councils derive Laboratory strategic direction from the Strategy Board, made up of selected NREL leaders and chaired by the deputy director.

Laboratory Administration: NREL is now completing implementation of performance-based management, an approach that stresses quantitative goal setting and measurement of performance for improved results. Goal setting and measurement of performance is linked from the corporate level to the center level and then to each team and individual, so that each individual understands and appreciates the contribution she or he is making toward the success of the Laboratory.

NREL is using an approach called a "balanced scorecard"[9] to track Laboratory progress toward its strategies, which includes performance measures from four different perspectives: customer, innovation, financial, and internal. NREL's corporate balanced scorecard includes all of the performance measures listed in this strategic plan (see Section III). Besides the corporate performance measures, each center and many individual teams have developed their own balanced scorecards that support appropriate corporate goals and highlight additional goals specific to their work. These measures and targets are used to periodically assess progress for individuals, teams, centers, NREL management, and MRI.

Human Resources: Restructuring, reengineering and downsizing require new approaches to employing, retaining, training, evaluating, and compensating Laboratory personnel. The Laboratory is reviewing its job structure, compensation system, and performance evaluation methods to bring them into line with the new organizational structure and culture. The entire system of rewards and incentives will be reviewed to ensure agreement with the Laboratory's expectations for performance and strategic directions. Leadership training will continue, and team training is being developed for the entire staff. NREL also has a new program to foster creativity and innovation, which will provide the new ideas so critically needed to achieve our mission.

To strengthen NREL's position as a premier research institution, it is important to always seek opportunities to enhance our technical capabilities. For these reasons, NREL will explore selectively bringing in world-class researchers or technologists to help lead NREL toward its long-term goals, targeting photovoltaics and optoelectronics, biofuels, transportation systems, buildings, and applications and analysis. These additions could occur through various arrangements, including sabbaticals from universities, consultants, visiting professional exchange programs with industry or other laboratories, or regular hires.

Environment, Safety and Health (ES&H): NREL remains committed to strong programs to protect its employees, physical and intellectual assets, the public, and the environment. These programs are developed and implemented according to risk-based criteria, whereby ES&H controls are matched to the hazards present to provide appropriate levels of control at a reasonable cost. The ES&H programs are also sufficiently flexible and responsive to accommodate the ever-changing nature of the work NREL conducts.

Information Services and Technology: NREL is evaluating options for restructuring its hardware and software architecture to streamline and upgrade its information systems. This restructuring is intended to lower costs through more standardization, and upgrade the quality of information available to the Laboratory by replacing or significantly improving the administrative computer systems.

Facilities: EE has supported the development of several new specialized facilities for NREL during the last few years, which have allowed for some reduction in lease costs and provided badly needed technical capabilities. The goals of NREL's capital improvement program remain further reducing Laboratory operating costs and improving Laboratory operations efficiency by vacating leased facilities and consolidating operations into DOE-owned buildings on its two sites.

Subcontract Management: NREL has made great strides in lowering the cost and speeding the process of competing, awarding, and managing contracts (see Figure 2, page 9). NREL intends to make further improvements by working with DOE Headquarters and the DOE Golden Field Office to, for example, better identify the full costs of subcontract management and to clarify the roles and responsibilities of those in the subcontracting process so that subcontracts are handled more efficiently.

Project Management: NREL will implement improvements by using a "graded approach," streamlining planning documents, clarifying roles and responsibilities, developing a system of mentors, and instituting a much-improved information system for project managers.

Strategy 3: Strengthen the integration of our work with others through partnerships

In today's complex research and business environment, the combined strengths of different organizations must be brought to bear to further the missions of NREL and DOE. DOE directed its laboratories to be "integrated with the nation's R&D enterprise... [and to] be recognized as having strong, mutually supportive links to other agencies, universities, and industry." [10] As a national laboratory, NREL's mission to lead the nation to a sustainable energy future cannot be achieved without synergistic partnerships with, among other institutions, U.S. renewable energy and energy efficiency companies, energy producers and users, state and local governments, universities, the finance community, international organizations, nongovernment organizations, and others.

NREL has a history of working closely with renewable energy and energy efficiency industries. Following the principles outlined for the Laboratory when it was conceived,[11] 30%–60% of NREL's funding has gone to U.S. industry (and universities) each year since the Laboratory opened. NREL partners with companies to help with short-term technical problems and to provide long-term technical advances. Persons from U.S. industry serve on technical review panels at NREL, provide guidance to program plans, and work at NREL on exchange programs. NREL will continue to strengthen these efforts.

NREL also continues to work closely with the academic community. In 1995, the Laboratory had formal research subcontracts with 58 different U.S. universities and colleges, involving hundreds of faculty and students, besides the many less formal partnerships that occur among scientific professionals. The basic science that underpins advances in solar energy provides a fertile and exciting field for the education of future scientists. Expanded partnerships with universities will allow the Laboratory to strengthen its basic science activities and to broaden its technology base into related technologies. To further these partnerships, NREL will increase the number of sabbatical visitors from universities to NREL; in turn, the universities and their centers of excellence will benefit from more interactions with NREL researchers.

Energy efficiency and renewable energy technologies provide valuable solutions for state and local governments but not all state and local decisionmakers are aware of them. NREL provides analytical information for states, educates state legislators about these technologies, and provides relevant information, such as studies on industrial ecology.

Partnerships with the financial and business community and endusers, such as utilities and consumers, help with project implementation and improve understanding of the economic and institutional considerations in technology development. One of the specific activities that NREL intends to expand is sponsorship of Enterprise Growth Forums, which are periodic meetings between venture capitalists, others from the financial community, and private companies focussed on energy efficiency or renewable energy. The forums strengthen relationships between renewable energy entrepreneurs and the financial community and help companies find new investors. Another area of emphasis will be a national network of business incubators for new companies doing work related to energy efficiency and renewable energy, to help these firms tap the laboratory's information, expertise, and facilities.

The most important and rapidly growing markets for many renewable energy technologies today are overseas. In 1995, 82% of the worldwide photovoltaics market and 97% of the total

worldwide wind turbine market were installed outside the United States. The U. S. renewable energy industry must capture a significant share of these international markets to be viable. Current U.S. energy policies strongly support partnerships with the international community; the National Energy Policy Plan states: "In working toward sustainable international energy development, the Administration will encourage continued improvement of alternative energy and energy-efficiency technologies; worldwide use of U.S. energy technologies; broad dissemination of environmental technologies; and strong partnerships with energy officials around the world."[12] If NREL is to fulfill its mission, the Laboratory must understand real market needs—especially international markets—and the resultant impacts on technology development. To do this, NREL must continue developing relationships with other governments, agencies, and nongovernmental organizations, in ways that will support U.S. industry's role in developing international business in these technologies.

Strategy 4: Increase leveraging of EE funding

DOE encourages leveraging in its vision for its laboratories;[13] Secretary O'Leary's FY 1996 performance agreement directs the DOE laboratories to "enhance the Department's research impact through partnerships with industry and increase the amount of research performed for and with other government agencies and the private sector."[14]

NREL recognizes the value of leveraging DOE support for the Laboratory with non-DOE revenue sources. When consistent with DOE policy and in support of our mission, leveraging EE funding brings important benefits to NREL and DOE. Leveraging the public investment with private funds results in more mission-related progress than could be supported using only public investments—critically important as the nation strives for deficit reduction. Developing leveraged projects with industry inherently serves as a technology transfer and commercialization venue, increasing economic growth, jobs, and technological innovation. Leveraging revenue sources allows NREL to work on projects that help to broaden NREL's technical knowledge in ways that can contribute directly to EE's primary mission. Finally, the affirmation of a contribution by a non-DOE customer assures Congress and the American taxpayers that the market places a value on the work being performed and the public investment being made.

NREL is participating with other laboratories in a study on "Alternative Financing for R&D," led by DOE. This study is examining the many ways in which R&D in the public interest can be, and has been, supported or leveraged financially with lower levels of direct appropriations. Leveraging EE funding is not a new concept at NREL; currently, about 5% of NREL's funds come from non-EE sources, including ER, the National Aeronautics and Space Administration, and some private companies. NREL is contributing information on its experiences to the overall group, and is working on a subgroup exploring public and private joint R&D ventures. NREL will use the results of the broad study to explore new ways to leverage EE funding.

As examples of additional activities to leverage EE funds, NREL is considering offering materials and device characterization expertise and services using its state-of-the-art instrumentation, expertise in providing analyses of photovoltaics and electronics materials, and expertise in developing new specialized techniques and instrumentation. In another area, NREL is considering a new initiative to model the relationships between local climate and renewable energy resource availability and use. Also, NREL is considering ways in which its expertise in alternative financing (developing contracts for energy-related projects in which the contractor is repaid by the energy savings generated by the project) for energy efficiency and renewable

energy projects can be applied to a wide range of energy projects.

NREL is also working to streamline its process for handling the administration of projects funded by non-EE sources. A faster, more efficient process would make NREL more effective at solving short-term problems for many different types of customers.

III. NREL'S PERFORMANCE MEASURES

To effectively implement a strategic plan, quantifiable targets must be established that define success in accomplishing a strategy or objective in terms of the operations the organization can influence or control. Selected measures and targets NREL has chosen to track its progress in each of the four strategies are shown in the table below, and are discussed in the notes following the table. NREL has used some of the measures in the past, in which case measurement methodologies have been established and historical data are available. Other measures have not been made before, so NREL is in the process of developing measurement methodologies and developing baseline data. The measures and targets are intended primarily for NREL's internal use, not as a mechanism for comparing NREL to other laboratories or organizations.

Selected NREL Performance Measures and Targets

	Performance Measures	FY 1995 Actual	FY 1996 Actual	FY 1997 Preliminary Target
Strategy 1: Expand NREL's capabilities for research, development, and deployment assistance for DOE				
	Customer Satisfaction		Develop method	Develop baseline
	Successful Proposals Made		Develop baseline	10% improvement
Strategy 2: Support science and technology with world-class operations				
	Direct Labor Cost Multiplier	3.40	3.21	3.00
	Average Operating Cost per Research Full-Time Equivalent Employee	$173,000	$166,600	$160,200
	NREL Technical and Scientific Advances Adopted by Industry		Develop baseline	10% improvement
	Employee Satisfaction		Develop and pilot method	Develop baseline
	External Recognitions of Quality of Our People		35	40

	Performance Measures	FY 1995 Actual	FY 1996 Actual	FY 1997 Preliminary Target
	All NREL Individual Performance (measured by 360 degree review)			Develop method
	Project Management Quality Ratio		Develop baseline	100%
	Minimize Injuries and Illnesses OSHA Recordable Injury/Illness Rate (number per 100 employees) Avoidable Injuries (number)	2.5 12	1.2 4	2.4 5
	Scientific and Technological Impact Rate	56.7	47.7	52.5
	Revenue from Innovative Projects		Develop baseline	10% improvement
Strategy 3: Strengthen integration of NREL's work with others through partnerships				
	NREL Technical and Scientific Advances Adopted by Industry		Develop baseline	10% improvement
	Active Alliances		40, totalling $5.3 million	44, totalling $5.8 million
	Customer Satisfaction		Develop method	Develop baseline
Strategy 4: Increase leveraging of DOE/EE funding				
	Revenue Source Diversity	8.8%	6.0%	6.6%
	Customer Satisfaction		Develop method	Develop baseline
	Successful Proposals Made		Develop baseline	10% improvement
	Revenue from Innovative Projects		Develop baseline	10% improvement

Notes:

Customer Satisfaction: Methods for measuring NREL customer satisfaction are being developed, and may include written, telephone, and face-to-face initiatives by the Laboratory.

Successful Proposals Made: Methods for measurement include counting the number of proposals written and submitted to all potential customers, DOE and non-DOE; the number of proposals resulting in funding authorizations or legally binding contracts; and the dollar amount of the new proposals.

Direct Labor Cost Multiplier: This is the factor by which researchers multiply each direct labor dollar to approximate the total cost of their effort before fees for materials and subcontracts. Because of the variability of accounting methods among R&D institutions, NREL uses this measure to monitor its own progress over time, not to compare itself to other institutions.

Average Operating Cost per Research Full-Time Equivalent Employee: This is an alternative "overhead" efficiency measurement, to reflect the operating cost of managing the Laboratory relative to all research full-time equivalent employees.

NREL Technical and Scientific Advances Adopted by Industry: Recognizing that NREL technology must be adopted and used by industry to make a difference in reaching our vision of a sustainable energy future, this metric is intended to measure in absolute terms the number of ideas, techniques, products, or services developed or improved at NREL that have subsequently been adopted by the commercial sector or otherwise put into practice outside our Laboratory.

Employee Satisfaction: Deep personal and team-based revitalization and increased satisfaction are necessary ingredients in achieving high performance. This measure will be used to increase the understanding of our mission and the satisfaction felt from every employee in achieving the mission, and align our organizational elements toward achieving our mission.

External Recognition of Quality of Our People: As a world leader in science and technology, NREL has, and must continue to have, many staff members who are internationally known in their fields. This measure counts the total number of external recognitions such as memberships in national academies, fellowships in professional societies, and other significant national and international awards in science, technology, and support functions for leadership or excellence.

All NREL Individual Performance: NREL is in the process of developing a 360-degree Performance Evaluation Plan, based on using multiple sources of performance feedback.

Project Management Quality Ratio: This measure indicates the ratio of projects that meet a quality standard (defined as being completed on time, and on budget, and meeting quality specifications as agreed upon by the center director, the technology manager, and the project manager) to the total number of projects scheduled to be completed during the fiscal year.

Minimize Injuries and Illnesses: This measure has two components that together demonstrate a proactive approach to the well-being of our people and reflect the most likely measurable positive impact on lives. The OSHA Recordable Injury/Illness Rate is the number of recordable injuries and illnesses per 100 employees. Avoidable injuries is the total annual number of those injuries and illnesses that could have been avoided had proactive measures been properly implemented.

Scientific and Technological Impact: This measure indicates the extent of participation in, and impact upon, the scientific and technical community. It is currently calculated by summing the numbers of specific types of technical documents published plus actions related to patents, per 100 payrolled researchers.

Revenue from Innovation: To be successful over the long run, NREL must continuously generate, and develop to the point of revenue generation, new ideas and innovations. It is calculated as the percentage of total Lab revenue that comes from programs or projects that are less than three years old.

Active Alliances: Active alliances are the total number of written agreements that have been funded or that have had costs expended during the year that result in funding, add a significant capability or capacity, or result in significant contributions to NREL's mission. It is currently calculated by summing licenses, cooperative research and development agreements, and work-for-others agreements signed during the fiscal year. The total dollars may represent efforts expected to extend over several years.

Revenue Source Diversity: This is a measure of our ability to leverage EE funds with non-EE funds. It is calculated as operating revenue (budget authority) from non-EE sources as a percentage of total Laboratory operating revenue (budget authority).

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